Impact factors on fetal descent rates in the active phase of labor: a retrospective cohort study

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Abstract

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Keywords: Active phase; fetal descent; impact factors; labor; labor curve; labor progress; partogram.

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Introduction

In recent years, great attention has been paid to the progress of physiological labor and great effort has been made to distinguish physiological labor from non-physiological labor, especially in order to avoid cesareans [1]. In this evaluation process the widely used partogram of the World Health Organization (WHO), based on Friedman's work in the 1950s, has been modified and modern labor curves have been assessed [2–6]. Emphasis in research has been laid on the duration of the first stage of labor, especially on the progress of cervical dilation, and on the duration of the second stage of labor and to a minor degree on the progress of fetal descent. Prolonged labor is associated with a greater proportion of obstetrical interventions, such as oxytocin application and operative vaginal or cesarean delivery, and with adverse maternal and fetal outcomes [7, 8]. It has been found that 25%–55% of pregnancies are terminated by cesarean because of labor arrest, 10%–25% of them because of labor arrest in the second stage [9]. Therefore, it is essential that the progress of labor is correctly assessed and truly prolonged labor is identified. Several impact factors on labor, especially on cervical dilation, are mentioned in the literature, such as maternal body mass index (BMI), age, height and race, constitutional factors, parity, gestational age, fetal head position, fetal weight, fetal gender, labor augmentation or induction of labor, the use of epidural anesthesia and a longer first stage of labor [4, 5, 8, 10–18].

The American College of Obstetricians and Gynecologists, the National Institute of Child Health and Human Development and the Society of Maternal-Fetal Medicine suggest that management of labor should not be based solely on the duration of labor but also, and especially, on its progress, certainly within set time limits [1, 9, 19]. This is an important point, as prolonged labor is associated with higher rates of postpartum hemorrhage and infection, a greater proportion of labors requiring augmentation and emergency cesareans and higher intrapartum stillbirth rates [20].

Cervical dilation and fetal descent are the two most important parameters to evaluate labor progress and to be able to distinguish physiological from non-physiological progress. But little is known about the process of fetal descent over time. One of the reasons might be that frequent, recurrent vaginal examinations of a woman during childbirth are necessary to evaluate such progress. These encounter resistance or even rejection from women and from midwives for reasons of discomfort, pain, supposed risk of infection, disturbance of the birth process, etc. [21, 22]. Nevertheless, the most common method worldwide to evaluate labor progress is repetitive vaginal examinations to assess cervical dilatation and fetal descent, although this method is in a way inaccurate and there is a lack of consent to the frequency of such examinations [22–24]. Some recommend examinations every 2 h, others every 4 h and others only on indication [22].

In the present study, we focus on fetal descent rates, calculated in centimeter per hour, for every fetal station. In order to obtain standard values of fetal descent for women giving birth spontaneously, we calculate fetal descent rates in the active phase of labor for nulliparous and multiparous women on the basis of vaginal examinations every 2 h. In addition, we evaluate impact factors associated with an acceleration and deceleration of these rates.

Methods

In a retrospective cohort study at the University Hospital of Zurich in Switzerland (2600–2900 annual deliveries, cesarean rate around 40%), we evaluated all women who delivered between January 2007 and July 2014. The study was approved by the Ethical Committee of the district (KEK-ZH-Nr.2015-0105, approval date 1 April 2015) and we followed the EQUATOR reporting guidelines.

The study included all women with singleton pregnancies in vertex presentation at a gestational age of at least 34 0/7 gestational weeks with a spontaneous vaginal delivery. We chose 34 0/7 gestational weeks as the inclusion criterion as the same care is recommended for late preterms (from 34 0/7 to 36 6/7 gestational weeks) as for normal term births (from at least 37 0/7 gestational weeks) during labor according to the guidelines of the German Society of Obstetrics and Gynecology [25]. We excluded multiple pregnancies, non-cephalic presentations, vaginal-operative assistance, placenta previa, fetal malformations and intrauterine fetal demise, critical maternal diseases (such as severe heart and lung diseases, organ transplantations, collagenosis, etc.) and cases of incomplete data.

All deliveries in our hospital were attended by a certified midwife and a junior resident or a consultant. Maternal, fetal and obstetrical data, including electronic partograms, were recorded by the attending staff and documented in our computerized data systems during routine prenatal care, at admission to the labor ward, during delivery and postnatally (Perinat 5, in-house data system, Zurich, Switzerland and IntelliSpace Perinatal information system, Philips Healthcare, Netherlands).

Obstetrical care was standardized in our hospital. Fetal heart rate and uterine contractions were continuously monitored by cardiotocography in all patients. Vaginal examinations were performed at least every 2 h in the first stage of labor after dilatation had reached 3 cm and every hour in the second stage of labor to monitor progress, according to the definition of the majority of studies on labor onset and labor progress [19, 26]. Assessment of the fetal station by vaginal examination was performed by a trained midwife or an obstetrician, using a scale from −4 to +5 cm, always referring to the interspinal plane. The position of the fetal spine was assessed at entry to the labor ward and, if necessary, within the course of labor by transabdominal ultrasound and vaginal examination. The onset of the active phase of labor was assessed at 3 cm of cervical dilation in the presence of regular uterine contractions, according to the definition of the majority of studies on labor onset and labor progress, for both nulliparous and multiparous women [19, 26]. Oxytocin augmentation was applied according to a standardized protocol in our delivery ward in terms of inadequate labor progress in the active phase of labor, subject to the American College of Obstetricians and Gynecology/Society of Maternal-Fetal Medicine consensus recommendations and the American College of Obstetricians and Gynecology practice guidelines [1, 19]. Epidural anesthesia was applied on patient's request or upon medical advice.

Outcomes of the study were fetal descent rates in cm/h in the whole active phase of labor (active first stage and second stage of labor) according to parity and the evaluation of significant factors associated with accelerating and decelerating descent rates. As factors, different maternal (BMI, parity), fetal (weight, head circumference, head position, gestational age) and obstetrical (presence of epidural anesthesia) factors were evaluated. For this purpose, the median fetal descent rates at every fetal cephalic station (on a scale from −4 to +5 cm, referring to the interspinal plane) and their 10th and 90th percentiles were assessed according to parity groups.

As first-line approach, we chose non-parametric testing with the median and its 10th and 90th percentiles, as descent rates were not normally distributed but were left-skewed. Median fetal descent rates to traverse from one station to another were calculated by interval-censored regression. Therefore, the descent velocity for every centimeter of fetal descent was calculated from the time intervals between two vaginal examinations per person. First, parity groups were defined as nulliparous, primiparous and multiparous (para 2+) women. The Kruskal-Wallis test was used to determine significant differences in descent rates at every station, stratified by the three parity groups. As there were no significant differences between primiparous and multiparous women, these two groups were handled as one group (subsumed as "multiparous") in further statistical analysis. The Mann-Whitney *U*-test was then used to evaluate significant differences between the nulliparous and multiparous group.

Linear mixed models were used to evaluate the significant factors associated with labor progress in the whole group of parturients. Statistical analysis of the descent rates was performed using the statistical software package SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). Because of the large sample size, statistical significance was indicated at $P<0.001$ for the fetal descent rates and for the associated factors. Baseline characteristics of nulliparous and multiparous women were compared using the χ^2-test for categorical data and the unpaired *t*-test for continuous data (SigmaPlot 12.0, Systat Software Inc., CA, USA).

Table 1: Characteristics of the study population.

	Nulliparous n = 2417 (39.98)	Multiparous n = 3628 (60.02)	P-value
Age in years (±SD)	29.4 (5.4)	32.1 (5.1)	<0.001[a]
BMI in kg/m² (±SD)	27.3 (4.1)	28.3 (4.3)	<0.001[a]
Caucasian ethnicity n (%)	1578 (65.3)	2306 (63.6)	0.179
Epidural anesthesia n (%)	579 (24.0)	619 (17.1)	<0.001[a]
Age of gestation at delivery			
Preterm (34 0/7–36 6/7) n (%)	179 (7.4)	132 (3.6)	<0.001[a]
Term (37 0/7–42 0/7) n (%)	2238 (92.6)	3496 (96.4)	<0.001[a]
Occipitoanterior fetal position n (%)	2377 (98.4)	3509 (96.8)	<0.001[a]
Gender			
Male n (%)	1175 (48.6)	1786 (49.2)	0.659
Female n (%)	1242 (51.4)	1842 (50.8)	0.659
Fetal weight in g (±SD)	3252.4 (455.1)	3451.4 (464.0)	<0.001[a]
Head circumference in cm (±SD)	34.3 (1.4)	34.65 (1.3)	<0.001[a]
Labor induction n (%)	493 (34.8)	775 (21.4)	0.384

Data presented as mean (±SD) or n (%).
[a]Significant statistical difference between the groups (P < 0.001).

Results

Six thousand and forty-five patients were included in the final analysis. Of these 6045 patients, 2417 (40%) were nulliparous and 3628 (60%) were multiparous. The characteristics of the study population differed significantly in some factors (Table 1). Nulliparous women were younger, had a smaller BMI, used epidural anesthesia more often, had a lower mean gestational age at birth, gave birth more often to neonates in an occipitoanterior position and had neonates of lower birth weights and smaller head circumferences.

From the onset of fetal cephalic descent, the total median duration until delivery was 5.42 h for nulliparous women and 2.71 h for multiparous women. Thus, in multiparous women, fetal descent was twice as fast as in nulliparous women.

Median fetal descent rates followed a hyperbolic curve in both groups. The rates fastened during the course of labor and were significantly faster in multiparous women compared to nulliparous women, especially below the interspinal plane (Figure 1 and Table 2). The corresponding 10th and 90th percentiles showed a wide range of descent rates in both groups, but in a much greater amount in the multiparous group (Table 2).

Significant associated factors on fetal descent rates were maternal BMI, parity, fetal station, fetal position and epidural anesthesia (Table 3). In detail, an increasing maternal BMI, multiparity, a lower fetal station during the active phase of labor and a fetal occipitoanterior position accelerated fetal descent, whereas the use of epidural anesthesia decelerated it (Table 3).

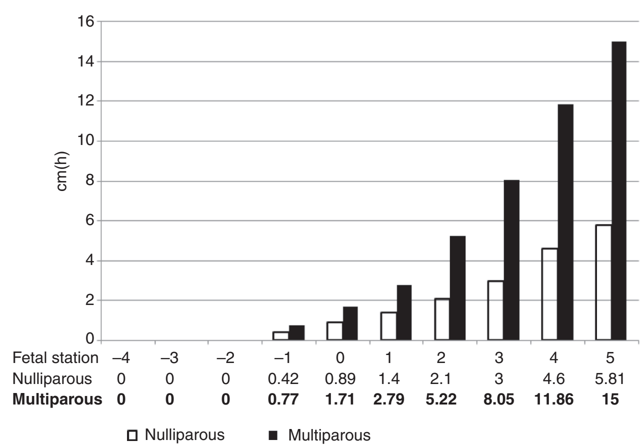

Figure 1: Median fetal descent rates of nulliparous and multiparous women in centimeter per hour (cm/h) according to fetal station.

Discussion

Fetal descent rates in the active phase of labor differ significantly between nulliparous and multiparous women in our study, with faster descent rates in multiparous women. Additionally, we found a large range of descent rates at every fetal station, especially in multiparous women, which signals a highly individual process of birth. Finally, several significantly associated factors on labor progress were evaluated and have to be taken into account when assessing labor progress.

Cervical dilation and fetal descent are the two most important parameters to evaluate labor progress. Cervical dilation is hereby the main process in the first stage

Table 2: Tenth, 50th and 90th percentiles of median fetal descent rates of nulliparous and multiparous women in cm/h according to fetal station.

Fetal station	Descent rates in cm/h					
	Nulliparous			Multiparous		
	10th Percentile	50th Percentile	90th Percentile	10th Percentile	50th Percentile	90th Percentile
−4	0	0	0	0	0	0
−3	0	0	0.07	0	0	0.32
−2	0	0	0.63	0	0	1.20
−1	0	0.42	1.35	0	0.77	2.86
0	0	0.89	2.96	0	1.71	6.95
1	0	1.40	4.78	0.79	2.79	10.55
2	0.70	2.10	7.50	1.35	5.22	22.86
3	1.11	3.00	10.56	2.00	8.05	35.07
4	1.69	4.60	13.52	3.61	11.86	45.94
5	2.31	5.81	18.00	4.74	15.00	45.19

Table 3: Significant impact factors on fetal descent rates.

Parameter	Impact	Fixed effects (95% CI)	P-value
Lower fetal station	↗[a]	0.30 (0.29–0.31)	<0.001
Multiparity (vs. nulliparity)	↗[a]	0.44 (0.41–0.47)	<0.001
Occipitoanterior fetal position (vs. occipitoposterior fetal position)	↗[a]	0.19 (0.10–0.27)	<0.001
Increasing BMI	↗[a]	0.01 (0.01–0.01)	<0.001
Use of epidural anesthesia (vs. without epidural anesthesia)	↘[a]	−0.16 (−0.19 to −0.14)	<0.001
Increasing fetal weight	↘	−5.23 (−9.02 to −1.45)	0.007
Preterm gestational age preterm (vs. term gestational age)	↘	−0.06 (−0.12 to 0.00)	0.105
Increasing fetal head circumference	↘	−0.01 (−0.02 to 0.00)	0.185

[a]Significant statistical difference ($P < 0.001$).
Impact: ↗ = accelerating factor, ↘ = decelerating factor, significance level $P < 0.001$.

of labor and fetal descent the main process in the second stage of labor. However, fetal descent not only appears in the second stage, but already begins in the first stage of labor. Most published studies evaluated the total duration of the second stage of labor, especially the mean duration, to distinguish physiological from non-physiological labor, but did not evaluate the progress of fetal descent in that stage. The total duration of the second stage of labor alone is an insufficient marker to distinguish physiological from non-physiological labor [1, 19].

As we and others have shown, the duration of labor is skewed, so in first line better the median than the mean values should be assessed, as we did here [4, 6, 27]. Besides, fetal descent follows a hyperbolic curve, so that the total duration of the second stage inadequately describes the progress of labor and descent rates should be preferred. Yet, only very rare studies have focused on fetal descent rates [4, 27]. Compared to our study, Graseck and colleagues calculated the duration from each station to another in hours, whereas we calculated descent rates in cm/h at every level of the fetal station. But when one converts the time intervals in Graseck`s study into descent rates, then the descent rates ranged from 0.625 to 5 cm/h for nulliparous and from 0.83 to 10 cm/h for multiparous women there. We found comparable median descent rates in nulliparous women from 0 to 5.81 cm/h and in multiparous women from 0 to 15 cm/h. As can be seen in our study, fetal descent distinctly accelerates after the fetal head has passed the interspinal plane, with descent rates being two to three times as fast for multiparous compared to nulliparous women.

Furthermore, a new aspect of our study is the evaluation of several accelerating- and decelerating-associated factors on fetal descent rates in the same study population. In our study, labor progress is significantly accelerated the lower the fetal head is positioned, by multiparity, fetal occipitoanterior position and increasing maternal BMI, which is in accordance with the findings of other authors [2–6, 8, 11–13, 16, 17, 27–32]. In contrast, labor progress in our study is decelerated by epidural anesthesia, which is also in accordance with the results of other authors [8, 15, 28, 33].

A strength of our study is the large sample size of more than 6000 deliveries in a single care center with a standardized protocol of obstetrical care and documentation. In contrast to the study of Graseck, the frequency of vaginal examinations was standardized in our hospital [4]. Moreover, we recorded fetal station on a more precise scale from −4 to +5 cm, rather than from −3 to +3 cm [4]. All birth attendants are trained on a regular basis in assessing fetal station by vaginal examination in mannequins, birth simulators and *in vivo*. As vaginal assessment of fetal station is, to a degree, inaccurate for the assessment of fetal descent [22–24], it could be replaced by transperineal ultrasound measurements, which correlate fairly well with MRI measurements, for reasons of accuracy and women's comfort [21, 24, 34, 35]. But routine assessment with the more precise ultrasound method is not feasible everywhere in standard obstetrical care. Nevertheless, the vaginal examination of a woman during birth provides useful information as it not only evaluates the degree of fetal descent, but also evaluates the degree of rotation and flexion of the fetal head, the amount of molding, the state of the amnion and the relation of the fetal head to the maternal pelvis, especially in dynamic situations such as during contractions [22].

A weakness of the study is in fact that the timing of the epidural application differed between the women, and the reason for the epidural application (only for pain relief or as an intervention due to obstructed labor) was not recorded and, therefore, could not be considered in the analysis. The timing of epidural anesthesia has an influence on median fetal descent rates at a given fetal station, but knowledge about this is inconsistent. In our study, the use of epidural anesthesia is associated with slower labor progress. Ohel et al. and Gross et al. [36, 37] found that the use of epidural anesthesia shortened the second stage of labor when administered early vs. late in the first stage of labor, mostly for the indication of pain relief. In contrast, a recent Cochrane Library Review about early vs. late initiation of epidural anesthesia for labor found no clinically meaningful differences regarding the length of the second stage of labor [38], and other authors even found a prolonged second stage [17]. Thus, the indication for epidural anesthesia, and probably not the timing, might be the more important factor of influence. Moreover, the timing and amount of oxytocin was not evaluated in this study, as it was not in other studies [4, 6]. But a study of Gross et al. [37] suggests that the start of oxytocin augmentation was associated with acceleration towards full dilatation in the first stage of labor and a shorter second stage of labor. Also, the application and timing of amniotomy was not evaluated in our study, but could have had an influence on fetal descent, as a study of Gross et al. [37] showed that amniotomy accelerated labor. To gain representative data about the physiological course of labor and of fetal descent, an evaluation of a great amount of "untouched" deliveries with no form of obstetrical interventions would be necessary. Unfortunately, in current obstetrical care, this setting is an illusion.

We state that delivery is a highly individual process with great inter individual differences but with some general tendencies. Fetal descent is not linear, but an exponentially increasing process, with faster descent rates in multiparous women compared to nulliparous women. However, as the process of labor is so individual, it is difficult to set up precise time limits or descent rates for the initiation of obstetrical interventions or for the definition of labor arrest. Many efforts have been made to set up such time limits or criteria for progression failure, some of them including single impact factors [1, 9, 19]. We could show that labor progress is significantly accelerated and decelerated by different associated factors especially after fetal descent below the interspinal plane. Thus, it is important to not only focus on the total duration of labor or on median or mean fetal descent rates alone, but also include possible associated factors in the analysis of each woman's labor progress. For further research, it might be helpful to assess fetal station by a more objective method than vaginal examination, such as ultrasound, and to evaluate the timing and amount of oxytocin used, the timing of amniotomy and the timing of and the indication for epidural anesthesia more precisely. By this, unnecessary interventions during delivery might be avoided or necessary interventions initiated when really needed.

Conclusion

Fetal descent is not linear, but an exponentially increasing process, with faster descent rates in multiparous women compared to nulliparous women. In addition, fetal descent is highly individual and affected by several impact factors. The diagnosis of labor arrest or prolonged labor should therefore be based on general research findings on the one hand and on an individual evaluation of every single parturient on the other hand. The assessment of descent rates and the evaluation of significant impact factors in our study might help in the decision process during labor.

Author's statement
Conflict of interest: The authors of this manuscript have no conflicts of interest to disclose as described by the Journal of Perinatal Medicine.
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